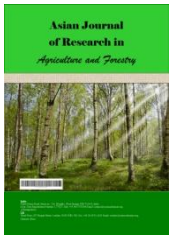

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Research on Blockchain-based Traceability System for Agricultural Products

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Short Communication

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ABSTRACT

To solve the problems of the existing agricultural products traceability system data storage security is not high, centralization is serious, data is easy to be tampered with and data trust, as well as to protect the quality and safety of agricultural products, safeguard the rights and interests of consumers and strengthen the supervision of agricultural products industry. In this paper, we propose a research on the safety traceability system of agricultural products based on blockchain on the traceability business process of the existing agricultural products traceability system. The decentralization of blockchain can ensure the immutability, transparency and accuracy of data traceability, solve the problems in traditional agricultural products traceability, improve the safety of agricultural products, and provide strong data support for the supervision of agricultural products industry. The advantages and challenges of implementing blockchain-based agricultural products traceability system are also elaborated, and the important links when applying blockchain technology to agricultural products traceability system are analyzed to provide reference for the research and establishment of blockchain agricultural products traceability system.

Keywords: Agricultural products; traceability; blockchain; decentralized; tamper-evident.

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1. INTRODUCTION

With the new coronavirus sweeping the world, agricultural products as the existence of a potential virus transmission pathway [1]. Traceability not only plays a crucial role in food quality and safety management, but also is an important method to control the pathway of infectious virus in agricultural products. Traditional IoT traceability systems provide a viable solution for quality monitoring and tracing in the food supply chain [2]. However, most IoT solutions rely on a centralized server-client model, which makes it difficult for consumers to be sure of the transaction information and understand the origin of the product. Blockchain is a cutting-edge technology with high security and full transparency that has great potential to improve traceability performance [3]. Therefore, this study proposes an architectural design framework based on blockchain and an integrated management system for agricultural product traceability process in view of the features and functions of blockchain technology [4].

2. STATUS OF TRADITIONAL AGRICULTURAL PRODUCT'S TRACEABILITY

Currently, governments have implemented agricultural traceability policies, to ensure the safety monitoring of agricultural products. Most traditional agricultural product traceability systems use technologies such as IoT and big data to increase data collection for traceability purposes, but they rarely achieve transparency in terms of security of traceability data, storage management and transactions in the supply chain [5]. There are mainly two types of traditional agricultural products traceability system implementation schemes as follows.

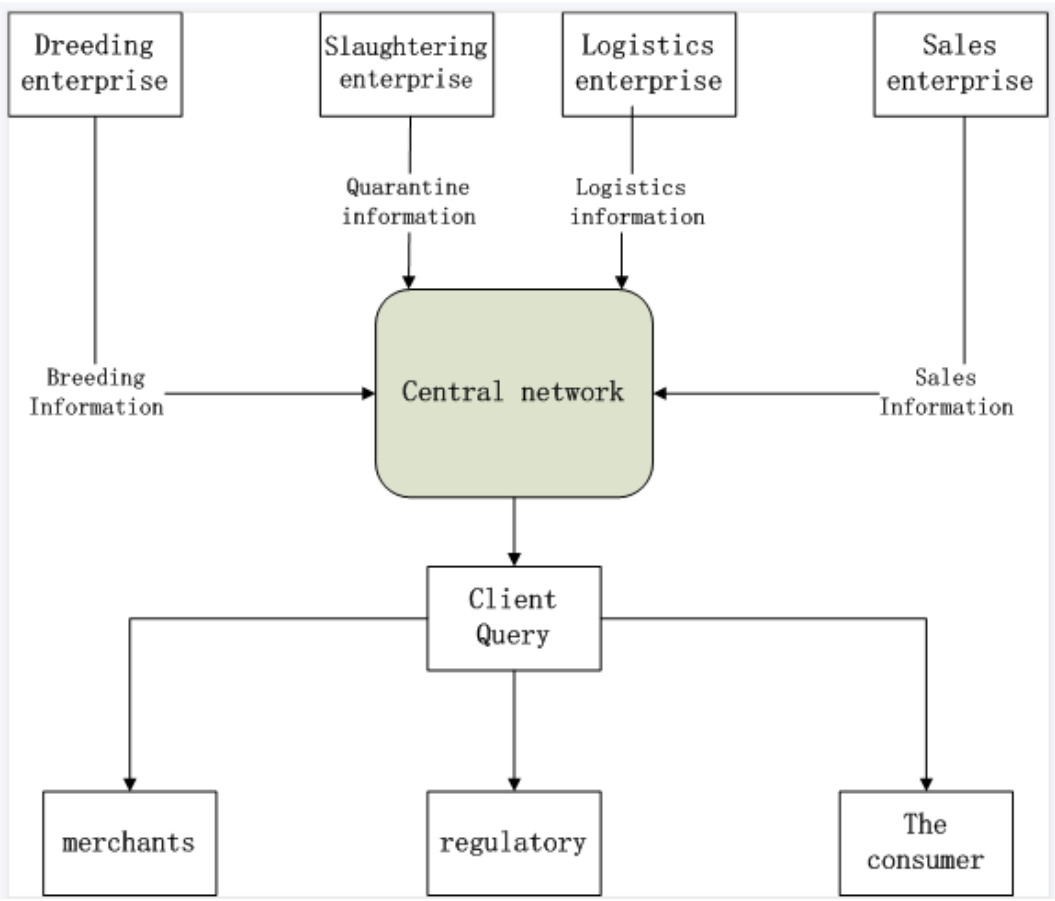

Fig. 1. The traditional traceability model of agricultural products

2.1 Paper-based Proof Method

The paper proof method is the most primitive one and was widely used in the early days. It is to provide a paper certificate provided by the producer of agricultural products as a traceability certificate to the seller and then The paper certification method is to provide a paper certificate from the producer to the seller for distribution to the consumer. Paper certificates are usually handwritten or printed, and they can be easily copied or forged. This old method was once used on a large scale, but it has been gradually replaced by information-based methods.

2.2 TranslcentralizedSoftware Traceability Platform

Since the way of paper proof is time-consuming and laborious, and easy to be imitated or forged, with the development and growth of the Internet industry, a traceability software platform can be developed to store the data of the production and circulation of agricultural products in the traceability software platform, and a QR code can be used to identify specific agricultural products, to achieve "one thing, one code "However, the software of this centralized storage mode has been used to store the data of the production and circulation of agricultural products in the software platform [6]. However, the data of this centralized storage mode software traceability system is easily tampered with, and the results of traceability inquiries cannot be guaranteed to be true and reliable.

As Fig. 1 shows the traditional traceability model of agricultural products, the function of each link is relatively simple, and only the data related to the corresponding link is uploaded to the central network, and consumers or regulatory authorities query the traceability information through the client to realize the traceability of agricultural products. Since each participating body in the agricultural products supply chain is relatively independent, there are often problems of large differences in resources among them, and the data of many nodes are incomplete or difficult to obtain, which makes it difficult to collect traceability information of agricultural products.

3. THE SIGNIFICANCE OF BLOCKCHAIN-BASED AGRICULTURAL PRODUCT TRACEABILITY SYSTEM

In recent years, there have been many food safety problems. To earn higher profits, some unscrupulous traders and food manufacturers have put the lives and health of consumers at risk and are profit-oriented, lacking a minimum of integrity. "Tainted milk powder", "lean meat", "gutter oil", "dyed steamed buns" and a series of other vicious incidents are increasing [7]. Food safety has gradually become a national and even global problem. The application of blockchain technology in the traceability of agricultural products can promote the upgrading of the agricultural industry and improve the competitiveness of products. On the consumers' side; the blockchain-based agricultural safety traceability system creates a world of trust consisting of algorithms in the field of agricultural product traceability, which can guarantee consumers' right to know, help improve consumers' confidence in the safety of agricultural products, and increase consumers' trust in agricultural products and related enterprises. On the enterprise side; complete blockchain traceability industry chain information helps enterprises improve the quality and information management of agricultural products, reshapes the trust relationship between consumers and producers, and further enhances the integrity and good development prospects of enterprises [8]. In terms of government supervision; based on each complete industrial traceability chain information on the blockchain, it can provide the supervisory department with real and effective supervision information, improve the efficiency of supervision, clarify the traceability object, traceability information, traceability link, traceability subject and other related contents, and lay a solid foundation for the safety and quality of agricultural products and sound supervision system.

Blockchain decentralization can ensure the immutability, transparency, and accuracy of data traceability, which has great potential in improving the performance of agricultural product safety traceability. Key technologies such as blockchain cryptographic algorithms and consensus algorithms are utilized to implant the agricultural product traceability system. Creating a world of trust consisting of algorithms in the field of agricultural product traceability is conducive to improving consumer confidence in the quality and safety traceability of agricultural products, thus enabling consumers to buy and eat with peace of mind [9].

4. BLOCKCHAIN

Blockchain is a distributed database that stores blocks in an orderly series by using cryptography

technology, with the characteristics of decentralization, collective maintenance, immutability, traceability, openness, and transparency, and is a very cutting-edge technology in the current information security field. It is an innovative application of information technology such as distributed data storage, peer-to-peer transmission, consensus mechanism, and encryption algorithm. The main functional features of blockchain are as follows.

4.1 Timestamp

In blockchain, it is required that the parties involved in a transaction cannot deny their actions. This entails a trusted timestamp on digitally signed transactions, thus solving a series of practical and legal problems. The workflow of the timestamp service is roughly as follows: firstly, the user performs Hash digest processing on the file data; the user makes a request for a timestamp and the hash value is passed to the timestamp server; the timestamp server signs the hash value and a date/time record to generate a timestamp; the timestamp data and the file information are bound and returned, and the user proceeds to the next electronic transaction operation.

4.2 Hash Functions

Hash function In blockchain, the original data is usually processed by a hash function to preserve its hash value. Hash functions, also called hash functions, have three properties: the input can be a string of any size; it produces a fixed size output; and the output result of a particular input string can be calculated in a reasonable time. As a means of encryption for transactions, it can achieve theoretical immutability; and the information of the previous and next block addresses contained in the node perfectly ensures the problem of data traceability.

4.3 Digital Signature

A digital signature uses an asymmetric encryption algorithm, that is, each node has a pair of public key and private key, the private key is only owned by itself, and the public key is open to the public, digital signatures include signature and verification, the signature uses the private key, a node with the public key if the signature can be successfully verified, it means that the identity of the private key owner is legitimate [10].

4.4 Consensus Mechanism

The consensus mechanism is how parties in a blockchain reach a consensus and determine the validity of a record. This is done by a computer system that uses cryptographic proofs. The consensus mechanism prevents data tampering during the traceability process.

4.5 Smart Contracts

As an event-driven, stateful program running on top of the blockchain system, smart contracts are able to keep and handle digital assets on the blockchain ledger; smart contracts running on a common platform are also able to achieve some of the functions of traditional application systems. The development of blockchain technology provides a good operating basis for smart contracts, which can play an important role in the blockchain (Review of Smart Contract Technology in Blockchain Systems). A smart contract is content that is implemented through code and has predetermined trigger conditions, and executes the code content when the external data source reaches the predetermined conditions [11]. It facilitates data sharing and continuous process improvement among supply chain participants. In addition, smart contracts ensure that parties are prevented from creating incorrect records, especially when used in conjunction with IoT devices. The exact process is shown in Fig. 2.

5. BLOCKCHAIN-BASED TRACEABILITY SYSTEM FOR AGRICULTURAL PRODUCTS

5.1 A Framework of Agricultural Product Traceability System Built on Blockchain Technology

Blockchain system generally consists of data layer, contract layer, network layer, consensus layer, incentive layer and user layer. Combining the characteristics of agricultural products, the traceability system of agricultural products is divided into data access layer, contract layer, data service layer and user layer. As shown in Fig. 3.

5.2 Agricultural Product Traceability System Built on Blockchain Technology

In order to be able to quickly and accurately trace the production place of agricultural products, the

planting place and the related responsibilities of each participating body in the process of circulation, the traceability system of agricultural products based on blockchain technology is constructed under the framework conditions of building the traceability system of agricultural products, as shown in Fig. 4.

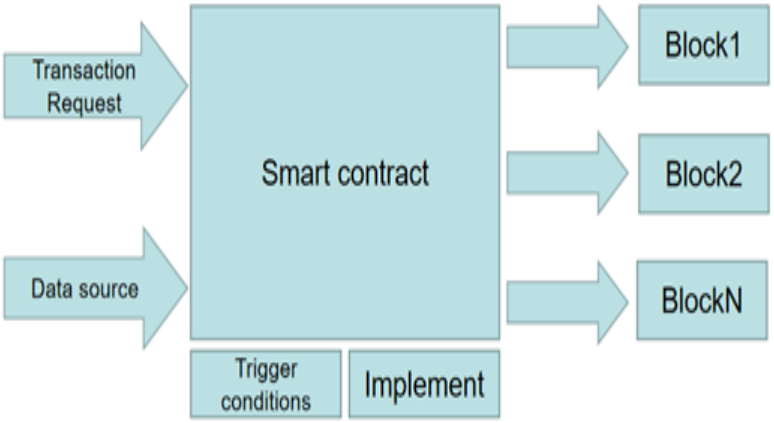

Fig. 2. Smart contract diagram

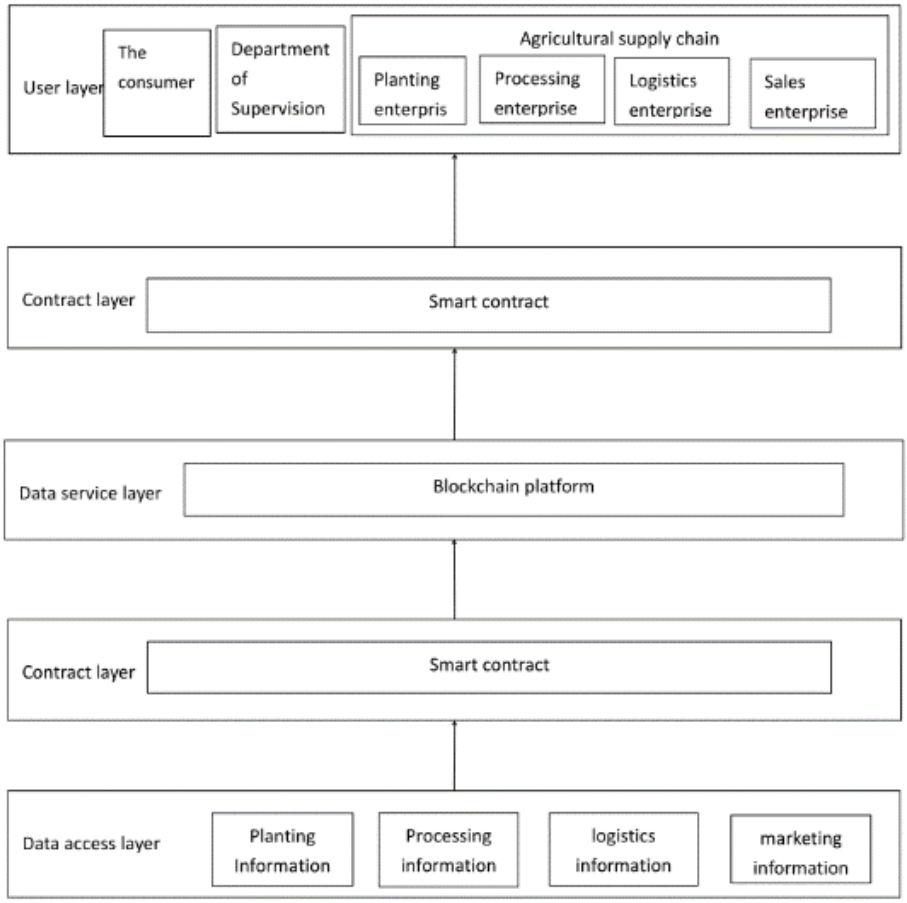

Fig. 3. The framework of agricultural product traceability system built by blockchain

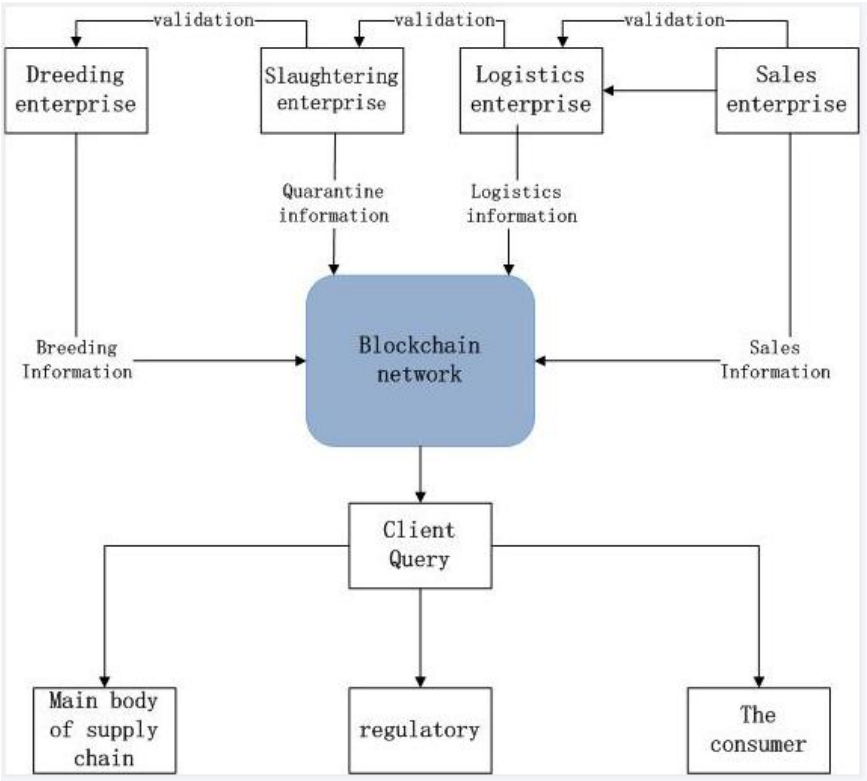

Fig. 4. Blockchain-based traceability model for agricultural products

In Fig. 3, we analyze the general model of agricultural products supply chain traceability, combine the characteristics of the current traceability environment, and propose the integrated traceability model of agricultural products supply chain, add the data acceptance link to the agricultural products circulation link to ensure that the traceability information from the previous link is true and reliable, and add the query channel of each supply chain subject in the client, so that each supply chain subject can also view and supervise the relevant traceability information of other links. Traceability information of other links can also be viewed and monitored by each supply chain body [12]. At the same time, it can be seen that it is able to maintain a consistent view and agreement among the participants of each link, confirm and accept for the corresponding link, so that different enterprises in the agricultural products, each of which is the main body, play a consensus role. The main features are as follows.

(1) Planting: The planting stage represents all agricultural activities implemented on the farm. Farmers use raw materials and organic materials (fertilizers, seeds, animal breeds and feed) to grow agricultural crops.

(2) Processing: This stage involves the total or partial transformation of the primary product into one or more other secondary products. This is expected to be followed by a packaging phase in which each package can be uniquely identified by a production lot code containing information such as the date of production and the list of raw materials used.

(3) Logistics: Once packaged and labeled, the products will be sent out in the logistics phase. Depending on the product, the delivery time is set within a certain range and the appropriate transport conditions such as refrigeration, insulation, etc. are provided.

(4) Distribution: At the time of distribution, the product is delivered to the retailer who performs the sale of the product. The end user will be the customer who buys the product.

(5) Consumption: The consumer is the end-user of the chain. After purchasing the product, the consumer can check the traceable information of the product regarding quality standards, country of origin, production method, etc. through the webpage and mobile APP.

(6) Supervision: In the supervisory chain, the supervisory department has the highest inquiry authority and has the right to inquire all the procedures and information of each link, and when problems arise, they can supervise and check against the relevant information.

6. PROBLEMS AND COUNTER-MEASURES SUGGESTIONS OF BLOCKCHAIN-BASED AGRI-CULTURAL PRODUCT TRACEABILITY

6.1 Problems of Blockchain-Based Agricultural Product Traceability

6.1.1 Poor agricultural product safety system

Although the underlying blockchain of the agricultural product traceability system greatly improves the efficiency of traceability information data, the cost is relatively high, and thus the construction process is slow. The construction of the agricultural product traceability system involves various aspects such as production, processing, transportation, sales and supervision of agricultural products. During the production and processing of agricultural products, various data and information should be recorded in detail and relevant databases should be set up for storage. In the production areas, warehouses, transport vehicles and other modern electronic equipment installed in the data collection and recording, arrange personnel to collect records and regular maintenance of equipment. This is a long-term and costly project, which is difficult for farmers, small and medium-sized food enterprises, etc. to undertake, and their willingness to cooperate is low, so the current agricultural product traceability and safety system is not sound.

6.1.2 Inconsistent technical standards for traceability

The current lack of complete and unified technical standards and regulations in the agricultural products traceability industry has affected the promotion and application of traceability system strategies. However, in terms of traceability, the standards of traceability information are not consistent among countries, different brands collect different information, and the identification marks on agricultural products are not completely consistent. Some agricultural products have complete information, including production time, production place, production environment, circulation time and circulation place, etc., yet the information on some agricultural products is only the production place and production time. The lack of uniformity in these technical standards has increased the difficulty in the implementation of traceability technology, which is not conducive to the construction of the traceability system for agricultural products and has prevented more countries related to agricultural products from joining the traceability system

6.2 Countermeasure Suggestions of Blockchain-Based Agricultural Products Traceability

6.2.1 Vigorously promote the development of blockchain technology and other emerging internet technologies

Blockchain, as a new Internet technology, still faces challenges when applied to the traceability of agricultural products, and the construction of the traceability system of agricultural products is a long-term project involving multiple subjects, fields and levels, while the quality and safety of agricultural products is the key link to realize the traceability of agricultural products, and combined with the construction of the blockchain-based agricultural products system, blockchain still needs to be vigorously promoted and developed.

6.2.2 Establish unified and standardized traceability standards for agricultural products

Countries should form unified standards involved in the traceability system as soon as possible, standardize the application as well as development of the agricultural products traceability system, make the agricultural products traceability information consistent, so that various enterprises, farmers and retail households can use one data format to complete the synchronous uploading of all data information when using the agricultural products traceability system supported by blockchain technology, without learning more complicated operation techniques. This provides convenience for data information management in the agricultural product traceability system and further promotes the construction, application and promotion of the agricultural product traceability system.

7. CONCLUSION

The article analyzes and researches the agricultural products traceability system based on blockchain technology, which makes information data more secure, greatly reduces the risk degree of human tampering, and solves most of the current problems of agricultural products traceability management. Let agricultural products from production, processing to transportation and sales, from the origin to the hands of consumers, each link of which has data information to be found, and no matter which link has problems, the source of the problem can be found in the shortest time to minimize the harm, which requires a complete set of traceability system. At present, in addition to the traceability system, a series of elements such as relevant laws, standards and testing are needed to ensure the quality and safety of agricultural products.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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